JCS Journal of Chest Surgery
https://doi.org/10.5090/jcs.23.072
pISSN: 2765-1606 eISSN: 2765-1614
J Chest Surg. 2023;56(6):431-434

Clinical Research

Fracture of the Second Rib: An Indirect Sign of Serious Trauma Like Fracture of the First Rib?

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ARTICLE INFO
Received June 8, 2023
Revised August 29, 2023
Accepted September 28, 2023

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Background: The first 3 ribs are anatomically well-protected, shielded by the large thoracic muscles, the shoulder girdle, and the arm. A significant force is required to fracture these ribs; thus, such fractures suggest a high-energy trauma and are associated with injuries to vital organs of the thorax, such as the aorta, the heart, the lungs and the great vessels.
Methods: A retrospective analysis was conducted over a 10-year period at a single hospital. The study assessed patients with fractures of the second rib, including their concurrent injuries and the overall severity of their trauma.
Results: Among the 76 patients included in the study, the average age was 47.35 years, 81.5% were men, and 19.5% were women. Thirteen patients (17.1%) survived their injuries. The most common causes of injury were road traffic accidents (63%) and pedestrian injuries (22%). The patients who did not survive sustained injuries to an average of 5 additional organs, while survivors had injuries to an average of 2.07 additional organs. Left rib fractures were the most frequently observed (46%). The most serious concurrent injuries reported were to the aorta (5.26%), heart (10.52%), lung (52.36%), head (57.89%), liver (30.2%), spleen (26.31%), and kidney (17.1%).
Conclusion: As indicators of serious injury to vital endothoracic organs, isolated fractures of the second rib should be considered equal to first rib fractures in clinical importance.

Keywords: Ribs, Thorax, Aorta, Traffic accidents, Heart injuries

Introduction

The existing literature emphasizes the clinical importance of a first rib fracture as an indicator of severe trauma, including non-thoracic organ injuries. The anatomically well-protected first ribs require a significant amount of kinetic energy to fracture. This energy is dissipated throughout the body and may indirectly cause serious injuries to the head and neck, spinal cord, and great vessels, with a high overall rate of mortality [1].

This study examined the significance of second rib fractures in the absence of first rib fractures. The second ribs share the same anatomical region as the first ribs, and thus benefit from the same protection. This study focused on documenting the concurrent injuries to vital intra-thoracic and extra-thoracic organs, while also assessing the overall severity of the trauma.

Methods

Included in this study were 76 patients with second rib fractures but no fracture of the first rib. These patients presented to the accident and emergency (A&E) department and were either hospitalized, died in the A&E department, or were dead on admission. Patient data were retrieved from the hospital and forensic department files with written permission (Table 1). The collected data were analyzed using the corresponding equations for qualitative and quantitative statistical parameters.

Patients in the survivor group provided written informed

https://doi.org/10.5090/jcs.23.072

Table 1. Patient demographics in a retrospective analysis of second rib injuries (n=56)

Characteristic	Value
Sex	
Male	62 (81.5)
Female	14 (18.5)
Age (median, yr)	43.5 (15–88)
Mechanisn of injury	
Road traffic accident	48 (63)
Pedestrian injuries	17 (22)
Falls	8 (11)
Knife	2 (3)
Crushing injury	1 (1)
Hospitalized survivors	13
Nonsurvivors	63
Second rib fracture	76
Left	35
Right	20
Bilateral	21
No. of injuries (mean)	
Hospitalized survivors	2.07 (0–5)
Nonsurvivors	5 (2–10)
Significance (p-value)	0.000039
Lateralization (mean)	
Left	5.2
Right	4.2
Bilateral	6
Associated injuries	
Aorta	4 (5.26)
Heart	8 (10.52)
Head injury	44 (57.89)
Liver	23 (30.20)
Spleen	20 (26.31)
Kidneys	13 (17.10)
Lungs	36 (52.36)

Values are presented as number (%), median/mean (range), or number, unless otherwise stated.

consent for the scientific use of their data. Ethics committee of the Agios Panteleimon-General Hospital of Nikaia approved this work (reference number: 22739-17/05/2022).

Results

Sixty-two men (81.5%) and 14 women (18.5%) were included in this study with an average age of 47.35 years (median age, 43.5 years; range, 15–88 years). Only 13 patients (17.1%) survived their injuries. The mechanisms of injury were road traffic accidents (63%, n=48), pedestrian injuries (22%, n=17), falls from a height (11%, n=8), penetrating injuries (3%, n=2), and one crushing injury (1%, n=1) (Table 1). Fractures of the left second rib were most common (46%, n=35), followed by fractures of both ribs (28%, n=21) and the right rib (26%, n=20).

The survivors had significantly fewer concomitant injuries to other organs (average, 2.07; range, 0–5) than nonsurvivors who had an average of 5 injuries (range, 2–10; p=0.000039). Fracture of the left second rib was associated with significantly more injuries (n=5.2) than the right second rib (n=4.2) (p=0.0007). As expected, bilateral fractures (n=6) were associated with the greatest number of injuries (p=0.0022).

The most serious concomitant injuries were injuries to the aorta, heart, head, liver, spleen, kidney, and lung. Aortic injuries were present in 5.26% of patients (n=4), with 50% of those involving the ascending aorta and 50% the thoracic descending aorta. All aortic injuries were ruptures, and there were no survivors. Three aortic injuries involved fractures of the left second rib and 1 involved bilateral second rib fractures (p=0.616).

Injury to the heart was present in 10.52% of patients (n=8), with recorded contusions and ruptures. Most of these injuries were associated with left second rib fractures (n=5) and bilateral second rib fractures (n=3, p=1.0). No heart injuries were reported with right second rib fractures.

Lung injuries were present in 52.36% of patients (n=36) with mixed contusions and ruptures recorded. Among the survivors, only 1.3% (n=1) had a lung rupture (p=0.001), while hemothorax was present in 56.57% (n=43).

Although 44 patients (57.89%) had head injuries, there were no head injuries among the survivors. (p=0.002). Liver injury was present in 23 patients (30.2%), and was more common with fractures of the left second rib (n=11, p=0.77). Twenty patients (26.31%) had rupture of the spleen and none survived. Spleen rupture was significantly more common in patients with left-sided ruptures (p=0.04). Kidney injury was present in 13 patients (17.1%), with reports of ruptured bladders in 3 of these patients and retroperitoneal hematoma in 1 patient.

The recorded orthopedic injuries included fractures of the clavicle (25%, n=19), sternum (18.42%, n=14), spinal column (25%, n=19), scapula (2.6%, n=2), pelvis (28.94%, n=22), upper limbs (27.63%, n=21), and lower limbs (23.68%, n=18). Fractures of additional ribs were also present in 92.1% of patients (n=70).

The 13 patients who initially survived spent an average of 4.15 days in the hospital. Three of these 13 died, 2 of whom had fractures of the left second rib and 1 of the right second rib; all had 5 other concomitant injuries. The cause of death was reported as myocardial ischemia and head injury.

Discussion

The first 3 upper ribs are well protected by the scapula, the clavicle, and the humerus as well as the large pectoralis major, pectoralis minor, trapezius, serratus anterior, serratus posterior rhomboideus, deltoid, and sternocleidomastoid muscles, which all provide a barrier to rib injury. Fractures of the first or second ribs suggest a magnitude of injury in which a large amount of energy is dissipated, rendering the head, neck, spinal cord, lungs, and great vessels at risk for serious injury. Mortality may be as high as 35% due to these concurrent injuries [2-4].

The second rib is an atypical and unique rib, while the first, 10th, 11th, and 12th are alike. It has the same angle as the first rib but is thinner and longer, and the shaft does not shift as it does in the typical ribs. It also has a large tuberosity for the attachment of the serratus anterior muscle. Along with the first and third ribs on each side, it forms the dome of the thoracic cavity [3]. The dome shape of the thoracic cavity offers increased strength because domes efficiently distribute stress forces along the entire structure and offer greater volume to surface area. These advantages are achieved using 30% less structural material than any other shape [5].

There were no similar studies concerning fracture of the second rib alone. Interestingly, although fracture of the first rib can be the result of other mechanisms such as fatigue or stress (sports), there were no such mechanisms reported for the second rib. Therefore, serious trauma is the only known cause of fracture of the second rib [6]. Conversely, fracture of the second rib was not an independent indicator of severe trauma. The severity of trauma in individual cases depended on various factors, including the mechanism of injury, the force involved, and the location of the injury. The concurrent injuries with the highest reported mortality were to the aorta and the heart. The mechanism of these injuries was the shared dissipated forces that resulted from significant kinetic energy [7,8].

Some studies have concluded that there is no association between these fractures and major trauma. However, in our study the serious injuries were necrotomic findings, since only one-fifth of the victims were hospitalized and those had no serious concurrent injuries [9,10].

In conclusion, a fracture of the second rib may be an indicator of severe injury with a high mortality rate, as is true for the first rib. In clinical practice, such a fracture should dictate a meticulous diagnostic workup.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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